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Study of liquid iron alloys at high temperature and high pressure by X-ray scattering using the double sided laser heated diamond anvil cell

In this study, we have done a structural investigation of the Fe-FeS and Fe-FeSi system in the solid and in the liquid state at high pressures (30, 40 and 50 GPa) and high temperatures (from 1500 K up to 3500 K) and for several compositions (10, 20 and 30 %at of light element). We also measured the melting relationship and the structures of the phases present at the solidus. Hence, we are able to reconstruct the evolution of the total phase diagrams up to 55 GPa.

The working energy was 47 keV (Sm K edge). X-ray beam was focused to a size of 3*3 microns. Temperature was monitored using a CCD spectrometer and the pressure was monitored using equation of state of NaCl [1] or of pure Fe [2].

We have done melting experiments on the Fe-FeS and Fe-FeSi system. The starting sample was a finely grinded powder. This sample was loaded into NaCl powder pressure medium and thermal insulator. Temperature is increased by continuous steps, and 30s diffraction patterns are taken at each steps (Figure 1b). Using this method, we could determine the eutectic temperature, the phase relation and also the liquid structure (Figure 1a).

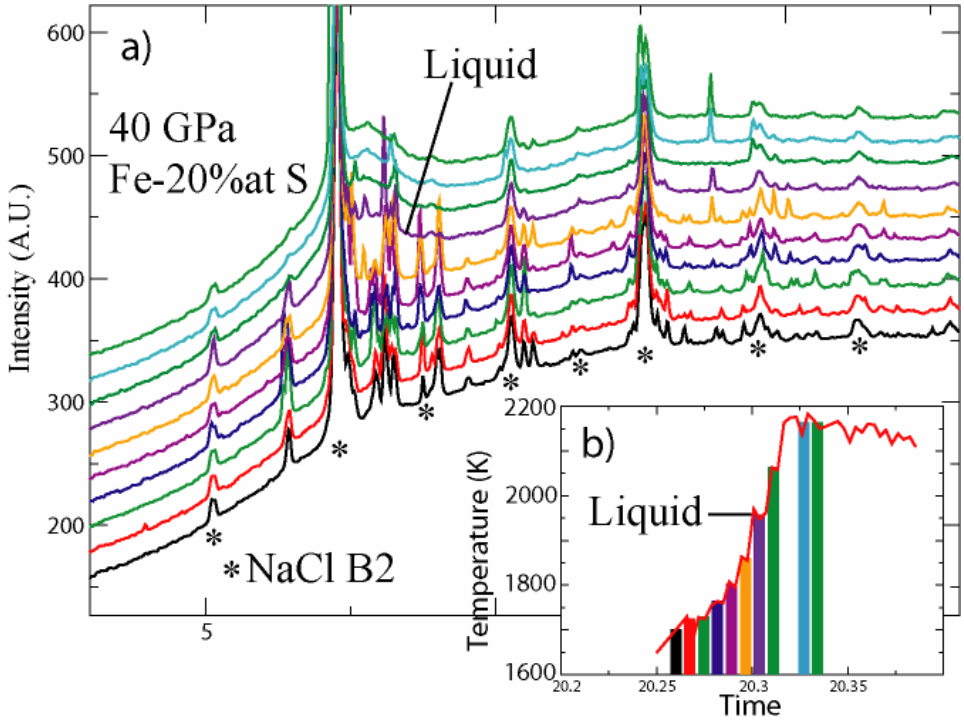

Figure 1 :A) Diffraction patterns of Fe-20%atS at 40 GPa and several temperature. NaCl is used as pressure medium and its diffraction peaks are indicated by stars. B) Increasing temperature (red lines) in function of time. Each columns, corresponding to 30s exposure time, referred to a diffraction pattern.

References

[1] J.M. Brown, The NaCl pressure standard, J. Appl. Phy. 86(1999) 5801-5808.

[2] T. Uchida, Y.B. Wang, M.L. Rivers, S.R. Sutton, Stability field and thermal equation of state of epsilon iron determined by synchrotron X-ray diffraction in a multi anvil apparatus, J. Geophys. Res. - Sol. Earth and Planets 106(2001) 21799-21810.